



Department of the Interior
Land and Management



Alaska State Office
222 West 7th, #13
Anchorage, Alaska 99513

Petrographic Survey and Appraisal of Reservoir Quality and Potential, National Petroleum Reserve—Alaska

Thomas C. Mowatt and
Joseph A. Dygas

JK
870
.L3
O6
no. 36
c. 2

BLM-Alaska Open File Report 36

September 1991

Author

Thomas C. Mowatt is a geologist for the Bureau of Land Management. Joseph A. Dygas is a geologist and the chief of the Branch of Lease Operations, Division of Mineral Resources for the Bureau of Land Management Alaska State Office.

Open File Reports

Open File Reports identify the results of inventories or other investigations that are made available to the public outside the formal BLM-Alaska technical publication series. These reports can include preliminary or incomplete data and are not published and distributed in quantity. The reports are available at BLM offices in Alaska, the USDI Resources Library in Anchorage, various libraries of the University of Alaska, and other selected locations.

Copies are also available for inspection at the USDI Natural Resources Library in Washington, D.C. and at the BLM Service Center Library in Denver.

#24862670

ID:88070040

JK
870
.L3
06
no. 36

Petrographic Survey and Appraisal of Reservoir Quality and Potential, National Petroleum Reserve—Alaska

Thomas C. Mowatt and
Joseph A. Dygas

Bureau of Land Management
Alaska State Office
Anchorage, Alaska 99513

Open File Report 36
September 1991

ERRATA

TUNALIK #1 TEST WELL

10,913' - PEBBLE SHALE. SUBLITHARENITE. VERY FINE SAND.
15-20% VISIBLE POROSITY (APPARENTLY PRINCIPALLY
SECONDARY, VIA DISSOLUTION OF CARBONATES, FELDSPARS,
LITHIC GRAINS). MODERATELY EFFECTIVE.
OIL-STAINED (?).

FAIR-GOOD (?) RESERVOIR QUALITY AS IS.
MODERATE POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION
(CHERT, CARBONATE -GRAINS AND CEMENT, OTHER LITHIC
GRAINS).

WALAKPA #1 TEST WELL

3060' - KINGAK. LITHARENITE. FINE SAND. 10% VISIBLE
POROSITY, OF FAIR (OR BETTER?) EFFECTIVENESS.

FAIR RESERVOIR QUALITY AS IS.
FAIR-GOOD POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION
OF LABILES (CARBONATE CEMENTS AND GRAINS; CHERT,
AND/OR OTHER LITHIC GRAINS).

SOME MINOR CLAYS (AUTHIGENIC-?--CHLORITE??) IN
PORES, AS WELL AS THE DEGREE OF COMPACTION TO WHICH
THE ROCK HAS BEEN SUBJECTED, ARE NEGATIVE FACTORS,
AS IS THE QUARTZ CEMENTATION.

INTRODUCTION

SUMMARY

As part of the reservoir management, resource assessment, and planning programs of the Bureau of Land Management in Alaska, the oil and gas resource potential of the National Petroleum Reserve in Alaska (NPRA) is undergoing review in light of new technical information, as well as changing national and international socioeconomic conditions. Emphasis in this work has been on integration of geological, petrophysical, geophysical, and engineering information, in order to provide a refined, more technically substantive knowledge base for resource assessment and management.

Petrologic-mineralogic characteristics have been reinvestigated, related to petrophysical parameters and wireline log responses, and integrated with available engineering data, for selected key wells within and peripheral to the NPRA. Particular attention has been directed to diagenetic relationships, effects on reservoir quality, and implications for untested portions of this sizable sedimentary basin. Emphasis has been on clastic rocks, Brookian as well as pre-Brookian. Only some 127 exploratory wells (all but one under government aegis) have been drilled within or adjacent to the NPRA (which is a geographic area on the order of 37,000 square miles—about the size of the state of Indiana). Many of these wells were only drilled to relatively shallow depths.

In almost every well drilled to any appreciable depth in the area, there have been noteworthy manifestations of the presence of hydrocarbons. The results to date might well be interpreted as being rather promising, actually, from a qualitative geological-geochemical perspective, in terms of the potential for significant resources to be present.

INTRODUCTION

The National Petroleum Reserve in Alaska encompasses a large portion of western Alaska, north of the Brooks Range, as shown by *Figure 1*. An appreciable portion of the NPRA is underlain by geologic terranes favorable for occurrences of petroleum resources. This has been recognized for many years (Gryc, 1985). The NPRA must also, of course, be considered in the overall regional context of northern Alaska, and contiguous offshore areas of the Beaufort Sea and the

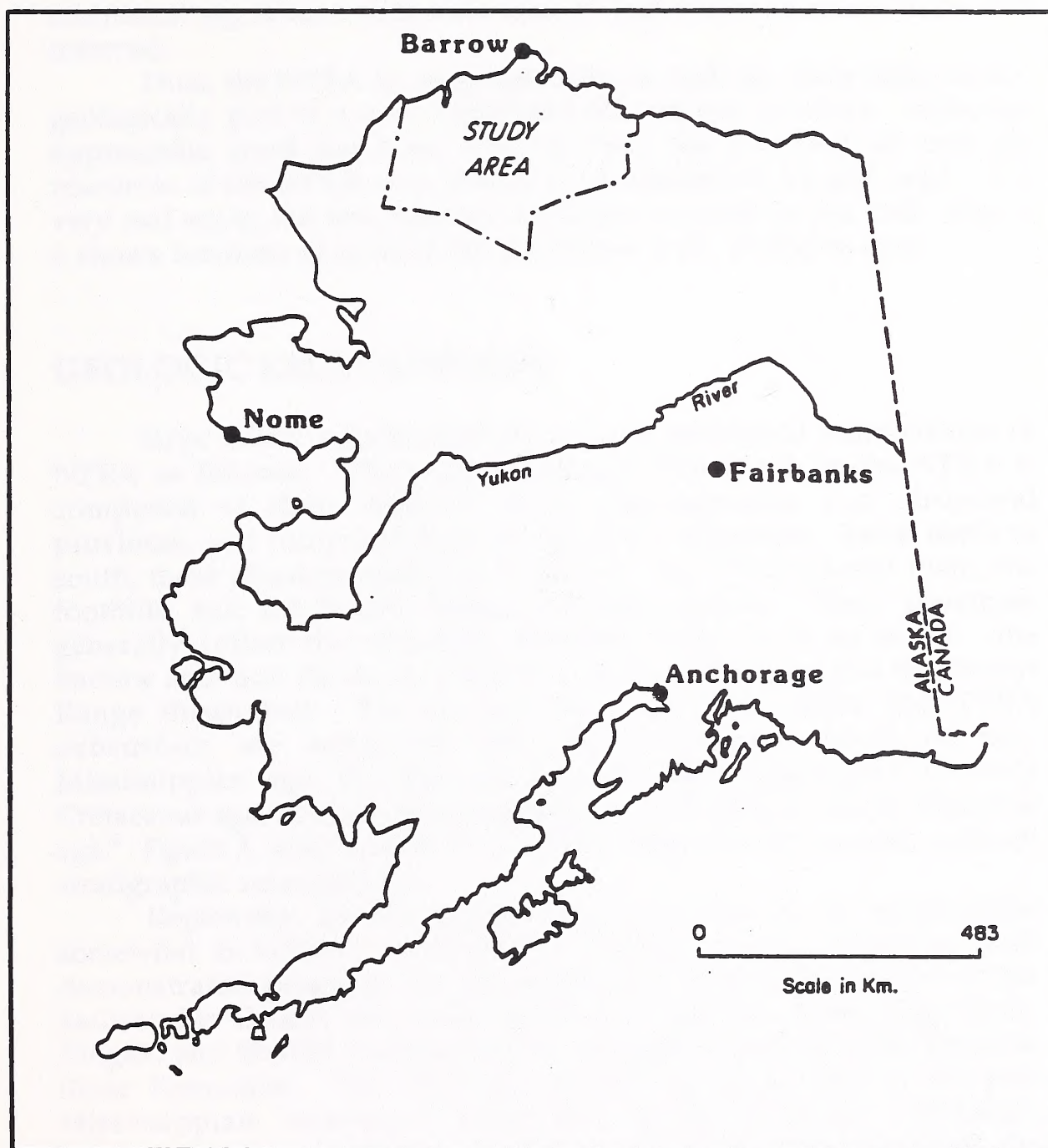


Figure 1. Location map, National Petroleum Reserve in Alaska (NPRA) .

Chukchi Sea. In essence, the area is comprised of the western portion of the North Slope of Alaska. The central portion, to the east, features very large known petroleum resources in the Prudhoe Bay, Kuparuk River, West Sak-Ugnu, etc. fields, while additional resources await further delineation. Farther to the east, in northeastern Alaska, additional significant accumulations of hydrocarbons are known, and inferred.

Thus, the NPRA is, geographically, as well as, more importantly, geologically part of a very significant oil and gas province. Although appreciable work has been done to date, the potential oil and gas resources of the NPRA area remain to be elucidated, by and large. In a very real sense, the area remains relatively untested by the drill. *Figure 2* shows locations of most of the significant wells drilled to date.

GEOLOGIC RELATIONSHIPS

Gryc (1985) summarized the general geological relationships of NPRA as follows: "The present geologic framework of the NPRA is composed of three distinct major physiographic and structural provinces, and comprises three stratigraphic sequences. From north to south, these physiographic provinces are: the Arctic Coastal Plain, the foothills, and the Brooks Range mountain system. These provinces generally reflect the structural elements from north to south: the Barrow arch and the Arctic platform, the Colville basin, and the Brooks Range thrust belt. The stratigraphic sequences within the NPRA subsurface are separated into the Franklinian rocks of pre-Mississippian age, the Ellesmerian rocks of Mississippian to Early Cretaceous age, and the Brookian rocks of Early Cretaceous to Holocene age." *Figure 3*, after Carter, et al (1977), illustrates the general regional stratigraphic relationships.

Regionally, known hydrocarbon resources can be summarized somewhat as follows. Stratigraphic horizons in the Ellesmerian with demonstrated potential are principally the Ivishak Formation of the Sadlerochit Group; the Lisburne Group; the Put River, Sag River, Kingak, and Shublik Formations; the Endicott Group; and the Kuparuk River Formation. The Thomson (Kemik) Sand, as well as the pre-Mississippian "basement" have also shown promise. Brookian sequence horizons with demonstrated production potential include the Nanushuk Group; West Sak and Ugnu sands; Walakpa clastics; and "turbidite" sandstones in the Point Thomson-Flaxman Island area, as well as to the east.

Furthermore, based on existing available information (literature, wireline logs, samples, petrographic thin-sections), strata of potential interest as petroleum reservoirs are not uncommon, areally, as well as

stratigraphically, within and adjacent to the NPRA. Hydrocarbon shows/manifestations are not uncommon in the subsurface, either. Northern Alaska seems to have no dearth of potential hydrocarbon source rocks in the subsurface. Given the relatively scanty drilling density in the region, the oil and gas resources potential has been by no means evaluated sufficiently to permit technically substantive conclusions to be drawn.

CURRENT RESERVOIR QUALITY STUDIES

Petrographic analyses have been carried out of more than four hundred thin-sections, from fifteen wells, presently available to us at the public repository of the Geological Materials Center (GMC), State of Alaska, Eagle River, Alaska. It should be emphasized that our present work deals only with such thin-sections as were available at the GMC.

The thin-sections studied thus far have been principally those from wells drilled by Husky Oil NPR Operations, Inc., under the aegis of the U. S. Geological Survey (USGS), 1977-1982. Some are from wells which predate the Husky-USGS program (U. S. Navy-Husky Petroleum Reserve Number Four programs). Published reports by Husky staff provided much valuable information regarding geologic, petrophysical, and engineering aspects. These reports, dealing with each well drilled by Husky for the USGS are on file at the GMC, as well as a number of other public facilities.

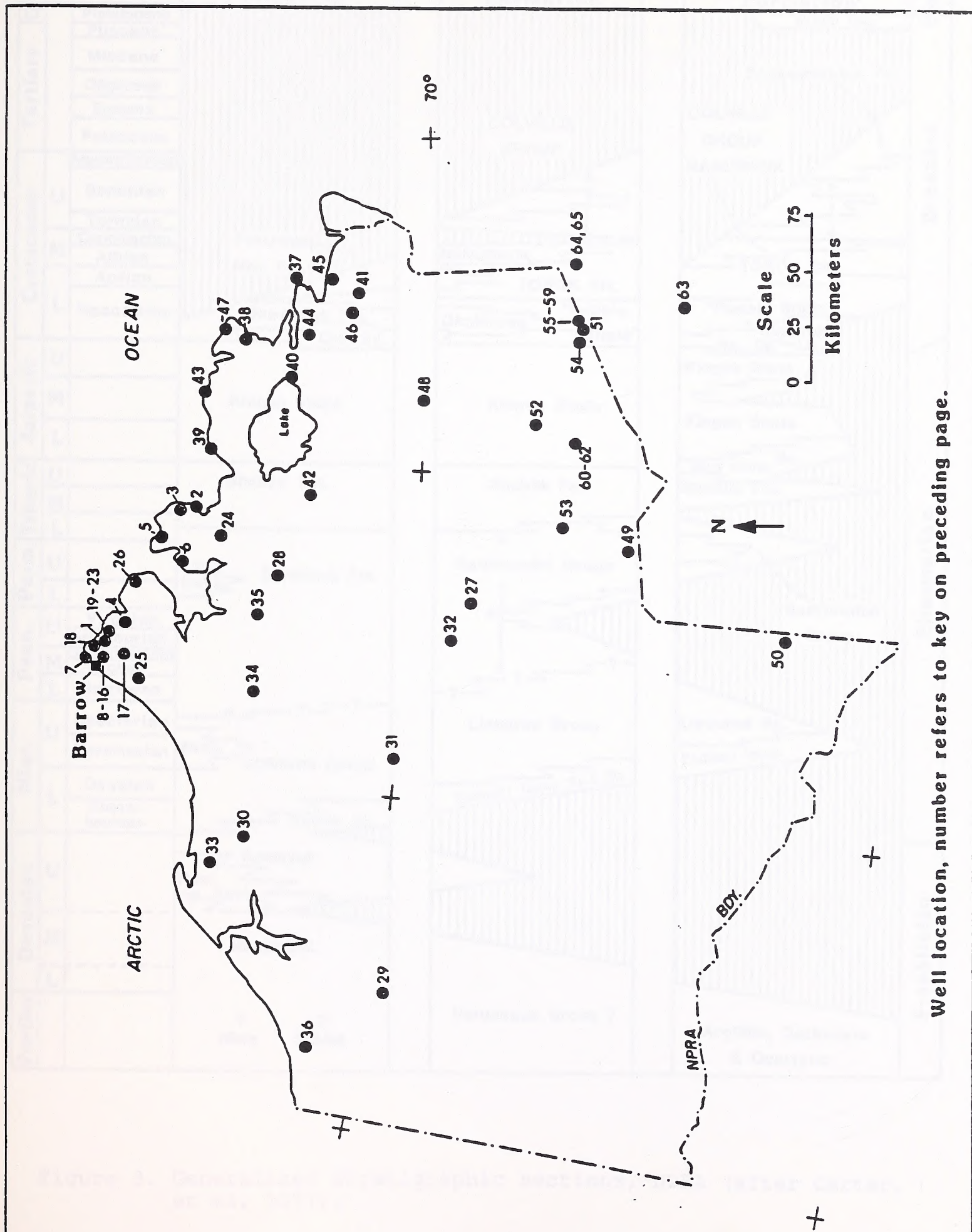
The present report is intended to discuss only some selected aspects—principally the petrography—of our current work, in response to expressed public interest. The comments which follow are merely intended to convey some of the essence of the lithologies and reservoir quality characteristics of some selected horizons of interest, from some selected wells. Our more extensive and complete petrographic descriptions, and related photomicrographs, are being prepared for release in open-file format.

The particular focus here is on reservoir quality considerations. At some risk of perhaps endeavoring to invoke a "Deus ex machina" (Bloch, et al, 1990), it should be noted that secondary dissolution porosity development seems not uncommon in many of the samples studied by us. Admittedly, per the comments of our friend and colleague Dr. Bloch, the proportional contribution to total porosities remains to be rigorously determined, quantitatively, as does its real importance—or lack thereof—relative to hydrocarbon accumulation. This is a key feature of emphasis in our present work. We have been concerned for many years with the presence/absence/origin(s) of discernible secondary dissolution porosity (in the classic sense so well-presented by Schmidt and McDonald, 1979a,b), and its possible role in reservoir quality, as well as potential significance to hydrocarbon

LEGEND FOR FIGURE 2

1. Avak - 1	17. South Barrow - 3	33. Peard - 1	*49. Knifeblade - 1, 2A
2. East Simpson - 1	18. South Barrow - 16	34. South Meade - 1	50. Lisburne - 1
3. East Simpson - 2	19. South Barrow - 12	35. Topagoruk - 1	51. Seabee - 1
4. Iko Bay - 1	20. South Barrow - 14	36. Tunalik - 1	52. Square Lake - 1
5. North Simpson - 1	21. South Barrow - 17	37. Atigaru Point - 1	*53. Titaluk - 1
6. Simpson - 1	22. South Barrow - 19	38. Cape Halkett - 1	54. Umiat - 1
7. South Barrow - 1	23. South Barrow - 20	39. Drew Point - 1	55. Umiat - 2
8. South Barrow - 2	24. South Simpson - 1	40. East Teshekpuk - 1	56. Umiat - 3
9. South Barrow - 4	25. Walakpa - 1	*41. Fish Creek - 1	57. Umiat - 4
10. South Barrow - 6	26. West Dease - 1	42. Ikpiukuk - 1	58. Umiat - 7
11. South Barrow - 7	27. East Oumalik - 1	43. J.W. Dalton - 1	59. Umiat - 11
12. South Barrow - 8	*28. East Topagoruk - 1	44. North Kalikpik - 1	*60. Wolf Creek - 1
13. South Barrow - 9	29. Kaolak - 1	45. So. Harrison Bay - 1	*61. Wolf Creek - 2
14. South Barrow - 10	30. Kugrua - 1	46. West Fish Creek - 1	*62. Wolf Creek - 3
15. South Barrow - 11	*31. Meade - 1	47. W.T. Foran - 1	63. Grandstand - 1
16. South Barrow - 13	32. Oumalik - 1	48. Inigok - 1	64. Gubik - 1
			65. Gubik - 2

Figure 2. Locations of wells, NPRA.



Well location, number refers to key on preceding page.

accumulation in various subsurface environments, particularly northern Alaska (cf. Mowatt and Mowatt, 1990). This is most important, of course, vis-a-vis "prediction" of "potential" reservoir qualities elsewhere, in rocks similar to those from which such prognostications are to be attempted. It is, in one sense, the crux of the matter, in terms of the attempted "assessment" of reservoir potential in the subsurface, prior to testing with the drill. This problem is not restricted to northern Alaska, of course. Future work will present the results of our attempts to inter-relate the petrographic studies with other attributes of the rocks.

SUMMARY COMMENTS, SELECTED HORIZONS, AND KEY WELLS

TUNALIK #1 TEST WELL

81 THIN-SECTIONS FROM THE GMC WERE STUDIED, REPRESENTING MATERIALS OVER THE DEPTH INTERVAL 1650- 17,885 FEET.

- 17,858'- UPPER LISBURNE. AMYGDALOIDAL BASALT (FLOW).
[THE RESERVOIR QUALITIES DO GET BETTER THAN THIS ROCK!].
- 17,269-72- UPPER LISBURNE. LITHARENITE-LITHIC WACKE. FINE SAND.
POOR RESERVOIR QUALITY AS IS.
SOME (FAIR OR BETTER) POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILE CONSTITUENTS (CHERT AND/OR CARBONATE LITHIC FRAGMENTS, AND/OR CARBONATE CEMENT.
- 17,135'- UPPER LISBURNE. SILICEOUS LIMESTONE.
POOR RESERVOIR QUALITY, OR POTENTIAL.
- 15,418.5'- IVISHAK FORMATION. LITHIC WACKE. VERY FINE SAND/SILT SIZE FRAMEWORK GRAINS DOMINANT. POROSITY NIL.
POOR RESERVOIR QUALITY OR POTENTIAL.
- 12,590'- PEBBLE SHALE. QUARTZ ARENITE. FINE SAND.
5% VISIBLE POROSITY (SECONDARY, AFTER LITHIC GRAINS)
TIGHTLY CEMENTED WITH QUARTZ, AS WELL AS LESSER CARBONATE MATERIALS (DOLOMITE; FERROAN CALCITE- REPLACIVE OF DOLOMITE, AT LEAST IN PART).

POOR RESERVOIR QUALITY .
POOR-FAIR? POTENTIAL FOR IMPROVEMENT, VIA CARBONATE DISSOLUTION.
- 12,585.8'- PEBBLE SHALE. SUBLITHARENITE. FINE SAND.
10-15% VISIBLE POROSITY (BOTH PRIMARY AND SECONDARY?).
OIL-STAINED.
QUARTZ, CARBONATE CEMENTS (INCLUDING DOLOMITE, FERROAN CALCITE).

MODERATE RESERVOIR QUALITY AS IS,
MODERATE POTENTIAL FOR IMPROVEMENT VIA DISSOLUTION OF CARBONATES.

10,938.75'- PEBBLE SHALE. SUBLITHARENITE. FINE SAND.
10% VISIBLE POROSITY PRINCIPALLY SECONDARY, AFTER
VARIOUS LITHIC GRAINS (CHERT. CARBONATES, MICAS, ETC.?).
[THERE ARE EXCELLENT EXAMPLES OF THIS HERE].

MODERATE RESERVOIR QUALITY AS IS.
FAIR POTENTIAL FOR IMPROVEMENT VIA DISSOLUTION OF
LITHIC GRAINS, AND/OR CARBONATE CEMENT.

10,936.1'- PEBBLE SHALE. SUBLITHARENITE. BIMODAL: FINE SAND AND
COARSE SAND.
5% VISIBLE POROSITY, OF POOR APPARENT EFFECTIVENESS.

POOR RESERVOIR QUALITY AS IS.
POOR POTENTIAL FOR IMPROVEMENT, SINCE THERE ARE NOT
SIGNIFICANT LEABILE DISSOLUTION CANDIDATES IN THIS
ROCK (JUST SOME CHERT GRAINS, MAINLY IN THE FINE SAND
"MATRIX."

10,913'- PEBBLE SHALE. SUBLITHARENITE. VERY FINE SAND.
15-20% VISIBLE POROSITY (APPARENTLY PRINCIPALLY
SECONDARY, VIA EFFECTIVE. OIL-STAINED(?).

FAIR -GOOD (?) RESERVOIR QUALITY AS IS.
MODERATE POTENTIAL FOR IMPROVEMENT VIA DISSOLUTION
(CHERT, CARBONATE- GRAINS AND CEMENT, OTHER LITHIC
GRAINS).

5560.65'- CORWIN/GRANDSTAND. LITHARENITE. FINE SAND.
15-20% VISIBLE POROSITY (MOSTLY PRIMARY, SOME SECONDARY
AFTER PLAGIOCLASE, LITHIC GRAINS). GOOD DEGREE OF
EFFECTIVENESS.

GOOD RESERVOIR QUALITY AS IS.
FAIR POTENTIAL FOR IMPROVEMENT VIA DISSOLUTION
(CHERT GRAINS; CARBONATE GRAINS AND/OR CEMENT; OTHER
LITHIC GRAINS.

3288'- CORWIN/GRANDSTAND. LITHARENITE. FINE SAND.
15-20% VISIBLE POROSITY (PRIMARY AND SECONDARY- AFTER
LITHIC GRAINS, FELDSPARS). MODERATE-GOOD
EFFECTIVENESS.
FAIR-GOOD RESERVOIR QUALITY, WITH FAIR POTENTIAL FOR
IMPROVEMENT VIA DISSOLUTION OF LABILES (CHERT,
FELDSPARS).

PEARD #1 TEST WELL

17 THIN-SECTIONS FROM THE GMC WERE STUDIED.

10,225'- PRE-DEVONIAN "ARGILLITE."
SILTSTONE-ARGILLITE.

NIL RESERVOIR QUALITY. ESSENTIALLY ONLY FRACTURE-POROSITY POTENTIAL.

9519'- ECHOOKA. LITHARENITE. FINE SAND.
NIL VISIBLE POROSITY.

NIL RESERVOIR QUALITY AS IS.
PERHAPS UP TO MODERATE POTENTIAL FOR IMPROVEMENT
ELSEWHERE, VIA DISSOLUTION OF LABILES (CARBONATE
CEMENT; CHERT GRAINS).

5417.8'- TOROK. LITHARENITE. FINE SAND. 20% VISIBLE POROSITY
(PRIMARY-?; SECONDARY- AFTER LITHIC GRAINS, CHERT,
PLAGIOCLASE). APPRECIABLE MICRO-POROSITY.

FAIR-GOOD RESERVOIR QUALITY AS IS. FAIR POTENTIAL FOR
IMPROVEMENT VIA DISSOLUTION OF LABILES (CARBONATE
CEMENT AND/OR GRAINS; CHERT AND/OR OTHER LITHIC GRAINS;
FELDSPARS).

3064-3046.4'-NANUSHUK. LITHARENITE. VERY FINE SAND.
20% VISIBLE POROSITY (PRIMARY; SECONDARY- AFTER
PLAGIOCLASE, CHERT, CARBONATE AND OTHER LITHIC GRAINS).

FAIR-GOOD-VERY GOOD(?) RESERVOIR QUALITY AS IS.
FAIR POTENTIAL FOR IMPROVEMENT VIA DISSOLUTION OF
LABILES (CARBONATE GRAINS AND/OR CEMENT; FELDSPAR;
OTHER LITHIC GRAINS).

WALAKPA #1 TEST WELL

16 THIN-SECTIONS- ALL OF POOR QUALITY IN TERMS OF PREPARATION-
FROM THE GMC WERE STUDIED. THESE SECTIONS REPRESENT MATERIALS
FROM THE DEPTH INTERVAL 3659-2063'.

3060'- KINGAK. LITHARENITE. FINE SAND. 10% VISIBLE POROSITY, OF
FAIR (OR BETTER?) EFFECTIVENESS.

FAIR RESERVOIR QUALITY AS IS.
FAIR-GOOD POTENTIAL FOR IMPROVEMENT VIA CHERT
AND/OR OTHER LITHIC GRAINS).

SOME MINOR CLAYS (AUTHIGENIC ? - CHLORITE ??) IN PORES,
AND THE DEGREE OF COMPACTION TO WHICH THE ROCK HAS
SUBJECTED ARE NEGATIVE FACTORS, AS IS THE QUARTZ
CEMENTATION.

- 2080'- WALAKPA SANDSTONE. LITHARENITE.
VERY FINE SAND-FINE SAND (WITH LESSER MEDIUM, COARSE,
AND VERY-COARSE SAND).

15% VISIBLE POROSITY OF GOOD APPARENT EFFECTIVENESS.

GOOD RESERVOIR QUALITY AS IS. GOOD POTENTIAL FOR
IMPROVEMENT VIA DISSOLUTION OF LABILES (CARBONATE
CEMENTS; FELDSPARS; CHERT GRAINS; PERHAPS GLAUCONITE-
10% TOTAL IN THIS THIN-SECTION- GRAINS AND
CEMENT/PSEUDOMATRIX [?]).
- 2076'- WALAKPA SANDSTONE. LITHARENITE. VERY FINE-FINE SAND.

20% VISIBLE POROSITY, OF GOOD-VERY GOOD DEGREE OF
APPARENT EFFECTIVENESS. MUCH OF THIS SEEMS TO BE
SECONDARY HERE.

GOOD-VERY GOOD RESERVOIR QUALITY AS IS.
GOOD POTENTIAL FOR FURTHER IMPROVEMENT VIA
DISSOLUTION OF LABILES (FELDSPARS;CHERT AND/OR OTHER
LITHIC GRAINS; CARBONATE CEMENT).
- 2065'- PEBBLE SHALE. LITHARENITE (FINE-MEDIUM SAND) PEBBLE
CONGLOMERATE.

15% VISIBLE POROSITY, OF FAIR-GOOD APPARENT
EFFECTIVENESS. FAIR-GOOD RESERVOIR QUALITY AS
IS. GOOD POTENTIAL FOR IMPROVEMENT VIA DISSOLUTION OF
LABILES (CARBONATE CEMENT; CHERT AND/OR OTHER LITHIC
GRAINS).

SOUTH BARROW #15 WELL

5 THIN-SECTIONS FROM THE GMC WERE STUDIED, REPRESENTING
MATERIALS FROM THE DEPTH INTERVAL 2184-2121'.

- 2184'- KINGAK (LOWER BARROW SANDSTONE).
LITHARENITE. FINE (TRACE OF MEDIUM) SAND.

20% VISIBLE POROSITY, OF VERY GOOD APPARENT
EFFECTIVENESS.

VERY GOOD RESERVOIR QUALITY AS IS.
MODERATE POTENTIAL FOR FURTHER IMPROVEMENT VIA
DISSOLUTION OF LABILES (CARBONATE CEMENTS; CHERT
AND/OR OTHER LITHIC GRAINS).

2165'- KINGAK (UPPER BARROW SANDSTONE).
LITHARENITE. FINE SAND.

10% VISIBLE POROSITY, OF FAIR APPARENT
EFFECTIVENESS.
FAIR RESERVOIR QUALITY AS IS.
FAIR POTENTIAL FOR IMPROVEMENT VIA (FURTHER)
DISSOLUTION OF LABILES (CHERT GRAINS; PLAGIOCLASE).

NEGATIVE FACTORS ARE CLAYS (MATRIX, PATCHY, 5%), DEGREE
OF COMPACTION, QUARTZ CEMENTATION.

WEST DEASE #1 TEST WELL

THIN-SECTIONS FROM THE GMC WERE STUDIED. NONE HAD BEEN PREPARED
WITH COLOR-DYED MOUNTING MATERIALS, HENCE ANY POROSITY
PRESENT IS NOT EASILY DETERMINED OPTICALLY.

3999.6'- SHUBLIK FORMATION. CONGLOMERATIC LITHARENITE.
SEMI-BIMODAL: FINE SAND AND FINER MATRIX, WITH MEDIUM-
SAND TO GRANULE-SIZE MATERIALS.

APPARENTLY OF POOR/NIL RESERVOIR QUALITY AS IS.
PERHAPS FAIR POTENTIAL FOR IMPROVEMENT, VIA
DISSOLUTION OF LABILES (CARBONATE FRAGMENTS, AND/OR
CEMENT [?]; CHERT, GLAUCONITE GRAINS).

CLAYS IN MATRIX (10%) ARE A NEGATIVE FACTOR.

3954'- SHUBLIK FORMATION. GLAUCONITIC LITHARENITE/
SUBLITHARENITE. MEDIUM/COARSE SAND.

APPARENTLY POOR RESERVOIR QUALITY AS IS. FAIR-GOOD (OR
BETTER ?) POTENTIAL FOR IMPROVEMENT VIA DISSOLUTION OF
LABILES (CARBONATE CEMENT AND/OR GRAINS; GLAUCONITE,
CHERT GRAINS).

3838'- SAG RIVER SANDSTONE. LITHARENITE/LITHIC WACKE (PATCHY
MATRIX, 15%). VERY FINE-FINE SAND FRAMEWORK GRAINS.

APPARENTLY POOR RESERVOIR QUALITY AS IS. POOR
POTENTIAL FOR IMPROVEMENT, DUE TO VERY FINE GRAIN SIZE,
AND MATRIX CLAYS.

PROBABLY A GOOD (OR BETTER ?) SEAL ROCK.

3732.3'- KINGAK (LOWER BARROW SANDSTONE). LITHARENITE/LITHIC WACKE. VERY FINE-FINE SAND SIZE FRAMEWORK GRAINS.

NIL APPARENT RESERVOIR QUALITY AS IS.
POOR POTENTIAL FOR IMPROVEMENT, DUE TO VERY FINE GRAIN SIZE, AND PERVASIVE CLAYS.

PROBABLY A GOOD (OR BETTER ?) SEAL ROCK.

DREW POINT #1 TEST WELL

62 THIN-SECTIONS FROM THE GMC WERE STUDIED. 53 OF THESE ARE FROM THE IVISHAK FORMATION, OVER THE DEPTH INTERVAL OF 7813-7602'. THE OTHER 9 THIN-SECTIONS ARE FROM OTHER SADLEROKHIT/SHUBLIK HORIZONS ABOVE (7601.1-7544').

7812'- IVISHAK FORMATION. LITHARENITE. VERY FINE-FINE (TRACE MEDIUM) SAND.

NIL VISIBLE POROSITY.

NIL RESERVOIR QUALITY AS IS.

POOR-FAIR? POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILES (CARBONATE CEMENT-PATCHY, POIKILOTOPIC; CHERT AND/OR OTHER LITHIC GRAINS).

NEGATIVE FACTORS ARE GRAIN SIZE, QUARTZ CEMENTATION, CLAYS (MATRIX, 5%), DEGREE OF COMPACTION (MODERATE +).

7801'- IVISHAK FORMATION. LITHARENITE. FINE (& VERY FINE) SAND.

5-10% VISIBLE POROSITY, OF POOR APPARENT EFFECTIVENESS.

POOR RESERVOIR QUALITY AS IS.

FAIR POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILES (CARBONATE CEMENT; CHERT AND/OR OTHER LITHIC GRAINS).

NEGATIVE FACTORS ARE GRAIN SIZE, QUARTZ CEMENTATION, CLAYS (MATRIX, 10%).

7721'- IVISHAK FORMATION. LITHARENITE/PEBBLE CONGLOMERATE. <5% VISIBLE POROSITY, OF POOR APPARENT EFFECTIVENESS.

POOR RESERVOIR QUALITY AS IS.

FAIR-GOOD? POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILE CONSTITUENTS (CARBONATE CEMENT; "MATRIX" SAND-SIZE CHERT AND/OR OTHER LITHIC GRAINS; CHERT PEBBLES).

7719'- IVISHAK FORMATION. LITHARENITE. VERY FINE-FINE SAND.
<5% VISIBLE POROSITY; PATCHY; SECONDARY, AFTER
ARGILLACEOUS LITHIC GRAINS, +/-?. OF POOR-FAIR? APPARENT
EFFECTIVENESS

POOR RESERVOIR QUALITY AS IS.

PERHAPS FAIR OR BETTER (?) POTENTIAL FOR IMPROVEMENT,
VIA DISSOLUTION (CONTINUED) OF LITHIC GRAINS, AND/OR
CHERT GRAINS; CARBONATE CEMENT.

PERVASIVE QUARTZ CEMENT IS, HOWEVER, A NEGATIVE
FACTOR VIS-A-VIS OVERALL RESERVOIR QUALITY POTENTIAL
HERE.

7709'- IVISHAK FORMATION. LITHARENITE/ PEBBLE CONGLOMERATE
AND. SILTSTONE/SHALE.

NIL VISIBLE POROSITY.

NIL RESERVOIR QUALITY AS IS.

POSSIBLY FAIR-GOOD (?) POTENTIAL FOR IMPROVEMENT, VIA
DISSOLUTION OF LABILES (CARBONATE CEMENTS; CHERT
GRAINS).

HOWEVER, THE FINER-GRAINED PORTIONS/LAYERS OF THIS
SPECIMEN LACK THIS DEGREE OF POTENTIAL AND, FURTHER,
ON A THIN-SECTION SCALE, WOULD BE NEGATIVE FACTORS IN
TERMS OF OVERALL POTENTIAL FOR IMPROVEMENT OF
RESERVOIR QUALITY.

IN SUM, OVERALL, THERE MAY BE, AT BEST, A MODERATE (?)
POTENTIAL FOR IMPROVEMENT.

7706'- IVISHAK FORMATION. LITHARENITE. COARSE-VERY COARSE
SAND.

NIL VISIBLE POROSITY.

NIL RESERVOIR QUALITY AS IS.

FAIR-GOOD, OR BETTER (?) POTENTIAL FOR IMPROVEMENT,
VIA DISSOLUTION OF LABILE CONSTITUENTS (CARBONATE
CEMENTS; CHERT GRAINS).

QUARTZ CEMENTATION IS A NEGATIVE FACTOR.

7622'- IVISHAK FORMATION. LITHARENITE. FINE (-MEDIUM-COARSE)
SAND.

NIL VISIBLE POROSITY.

NIL RESERVOIR QUALITY AS IS.

FAIR-GOOD (?) POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILES (CARBONATE CEMENTS- ESPECIALLY THE "BEADWORK"; CHERT AND/OR OTHER LITHIC GRAINS).

7600'- IVISHAK?/ SHUBLIK?. SANDY SILTSTONE ADJACENT TO (OVERLYING ?) GRANULE CONGLOMERATE (WEATHERED ?).

NIL VISIBLE POROSITY.

NIL RESERVOIR QUALITY HERE, AS IS.

PRIOR TO THE APPARENT WEATHERING (?) EFFECTS, THE CONGLOMERATIC MATERIAL MIGHT HAVE HAD FAIR OR BETTER POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILE CONSTITUENTS (CARBONATE CEMENTS; CHERT GRAINS).

PRIOR TO WEATHERING (?) AND INFLUX OF CLAY MATERIALS, ETC., INTO PORE SPACES, THE CONGLOMERATIC MATERIALS MIGHT WELL HAVE HAD GOOD-VERY GOOD RESERVOIR QUALITY.

W. T. FORAN #1 TEST WELL

3 THIN-SECTIONS FROM THE GMC WERE STUDIED. ALL ARE FROM THE KUPARUK SANDSTONE.

7541'- KUPARUK SANDSTONE. LITHARENITE. BIMODAL: VERY FINE-FINE SAND, AND COARSE-VERY COARSE SAND

10% VISIBLE POROSITY, OF GOOD APPARENT EFFECTIVENESS.

GOOD-VERY GOOD (?) RESERVOIR AS IS.

FAIR-GOOD POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILE CONSTITUENTS (CHERT AND/OR OTHER LITHIC GRAINS; CARBONATE CEMENT (WHICH IN ITSELF MAY REPRESENT DISSOLUTION REMNANTS IN THIS SLIDE)).

7539'- KUPARUK SANDSTONE. LITHARENITE. SEMI-BIMODAL: FINE-MEDIUM SAND, AND COARSE-VERY COARSE SAND.

10% VISIBLE POROSITY, OF FAIR APPARENT EFFECTIVENESS.

FAIR RESERVOIR QUALITY AS IS.

FAIR POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILE CONSTITUENTS (CARBONATE CEMENT; CHERT AND/OR OTHER LITHIC GRAINS).

ATIGARU POINT #1 TEST WELL

24 THIN-SECTIONS FROM THE GMC WERE STUDIED. ALL ARE FROM THE IVISHAK FORMATION, OVER THE DEPTH INTERVAL 8741-8712'. FRAMEWORK GRAIN SIZES RANGED FROM VERY FINE TO COARSE SAND.

8741'- IVISHAK FORMATION. LITHARENITE. VERY FINE-FINE SAND.

NIL VISIBLE POROSITY.

NIL RESERVOIR QUALITY AS IS.

FAIR (?) POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILE CONSTITUENTS (CARBONATE CEMENT; CHERT GRAINS).

NEGATIVE FACTORS ARE EXTENSIVE QUARTZ CEMENTATION, DEGREE OF COMPACTION, GRAIN SIZE, CLAYS IN PORES.

8731-8730'- IVISHAK FORMATION. LITHARENITE. MEDIUM SAND.

5-8% VISIBLE POROSITY, OF POOR APPARENT EFFECTIVENESS.

POOR RESERVOIR QUALITY AS IS.

POOR-FAIR (?) POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILES (CHERT, OTHER LITHIC GRAINS).

NEGATIVE FACTORS ARE QUARTZ CEMENTATION, DEGREE OF COMPACTION.

8718'- IVISHAK FORMATION. LITHARENITE. FINE SAND.

8% VISIBLE POROSITY, OF FAIR (?) APPARENT EFFECTIVENESS.

POOR- FAIR (?) RESERVOIR QUALITY AS IS. FAIR (?) POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILES (CHERT, OTHER LITHIC GRAINS).

NEGATIVE FACTORS ARE QUARTZ CEMENTATION, DEGREE OF COMPACTION, GRAIN SIZE, CLAYS-IN PORES.

NOTE: THIS THIN-SECTION SHOWED THE BEST (!) RESERVOIR QUALITY OF THE 24 SECTIONS OF THE IVISHAK AVAILABLE TO US FOR STUDY IN THIS WELL.

8717'- IVISHAK FORMATION. LITHARENITE. FINE SAND.

5% VISIBLE POROSITY, OF VERY POOR APPARENT EFFECTIVENESS (ESSENTIALLY NIL).

VERY POOR RESERVOIR QUALITY AS IS.

POOR POTENTIAL FOR IMPROVEMENT (VIA DISSOLUTION OF CHERT AND/OR OTHER LITHIC GRAINS), DUE TO QUARTZ CEMENTATION, DEGREE OF COMPACTION, GRAIN SIZE AND CLAYS- IN PORES.

BUT, NOTE: THERE IS, NOW, SOME SECONDARY POROSITY PRESENT, EVEN IN THIS "TIGHT" ROCK, WITHIN SOME OF THE CHERT AND OTHER LITHIC GRAINS.

8712'- IVISHAK FORMATION. LITHARENITE. FINE SAND.

5-8% VISIBLE POROSITY, OF POOR-FAIR (?) APPARENT EFFECTIVENESS.

POOR-FAIR (?) RESERVOIR QUALITY AS IS.

FAIR (?) POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION OF LABILES (CHERT AND/OR OTHER LITHIC GRAINS; TRACES OF CARBONATE CEMENT, GRAINS).

NEGATIVE FACTORS ARE QUARTZ CEMENTATION, DEGREE OF COMPACTION, GRAIN SIZE, CLAYS-IN PORES.

INIGOK #1 TEST WELL

24 THIN-SECTIONS FROM THE GMC WERE STUDIED.

15,215'- LISBURNE GROUP. BIOCLASTIC GRAINSTONE/PACKSTONE.

NIL VISIBLE POROSITY.

NIL RESERVOIR QUALITY AS IS

POTENTIAL FOR IMPROVEMENT THAT OF ANY SUCH CARBONATE ROCK, VIA DISSOLUTION AND/OR FRACTURING.

14,060-14,062'- LISBURNE GROUP. OOLITIC-BIOCLASTIC WACKESTONE AND INTERBEDDED SILTSTONE.

NIL VISIBLE POROSITY.

NIL RESERVOIR QUALITY AS IS.

POTENTIAL FOR IMPROVEMENT THAT OF ANY SUCH CARBONATE ROCK, VIA DISSOLUTION AND/OR FRACTURING.

THE INTERBEDDED SILTSTONE IS A DECIDED NEGATIVE FACTOR
IN TERMS OF OVERALL POTENTIAL, OF COURSE.

8851 AND 8212.9'- TOROK FORMATION. LITHARENITES. FINE SANDS.

NIL-TRACE VISIBLE POROSITY.

PERHAPS FAIR (OR BETTER ?) POTENTIAL FOR IMPROVEMENT
ELSEWHERE, VIA DISSOLUTION OF LABILE CONSTITUENTS
(CHERT AND CARBONATE GRAINS, FELDSPARS).

3081.9 (-3077.5)'- NANUSHUK GROUP. LITHARENITES. VERY FINE, FINE,
AND FINE-COARSE SANDS.

10-30% VISIBLE POROSITIES (PRIMARY; AND SECONDARY, AFTER
CHERT, OTHER LITHIC GRAINS, FELDSPARS).

FAIR-VERY GOOD RESERVOIR QUALITY AS IS.

FAIR-GOOD POTENTIAL FOR IMPROVEMENT, VIA DISSOLUTION
OF LABILE CONSTITUENTS (CHERT, FELDSPARS, CARBONATE
AND OTHER LITHIC GRAINS).

2636.5'- NANUSHUK GROUP. LITHARENITE. VERY FINE SAND.

25-30% VISIBLE POROSITY (PRIMARY; AND SECONDARY, AFTER
LITHIC GRAINS).

VERY GOOD RESERVOIR QUALITY, LOCALLY, AS IS, ALTHOUGH
ASSOCIATED CLAY-RICH HORIZONS MAY WELL MILITATE
AGAINST EFFECTIVENESS OF POROSITY ON A LARGER SCALE.

FAIR POTENTIAL FOR IMPROVEMENT OF POROSITY VIA
DISSOLUTION OF LABILE CONSTITUENTS (CHERT, CARBONATE,
AND OTHER LITHIC GRAINS, FELDSPARS).

ACKNOWLEDGEMENTS

The continued support and encouragement provided by J. Santora, Deputy State Director, Mineral Resources, Alaska State Office, Bureau of Land Management, are greatly appreciated and acknowledged with sincere thanks. The professional working environment afforded has been most conducive to substantive professional productivity.

The continued assistance and support provided by the Alaska Resources Library, Bureau of Land Management, has, as always, been exemplary. It is a pleasure to acknowledge the cooperation of the capable, helpful, diligent and pleasant staff, headed by M. Shepard, Supervisory Librarian.

Dr. J. Reeder, Curator of the Geological Materials Center, provided invaluable assistance. We will be co-authoring some of the reports now in preparation on certain wells, as a result. Discussions with Bureau of Land Management colleagues A. Banet, R. Bascle, G. Brougham, R. Foland, C. Gibson, D. Lalla, and A. Seidlitz were quite helpful as well.

REFERENCES CITED

Bloch, S., J. H. McGowen, and J. R. Duncan, 1990, Porosity enhancement from chert dissolution beneath Neocomian unconformity: Ivishak Formation, North Slope Alaska: Discussion: AAPG Bulletin, v. 74, p. 85-88.

Carter, R. D., C. Mull, K. Bird, and R. Powers, 1977, The petroleum geology and hydrocarbon potential of Naval Petroleum Reserve No. 4, North Slope, Alaska: U. S. Geological Survey Open File Report 77-475, 61 p.

Gryc, G., 1985, The National Petroleum Reserve in Alaska: U. S. Geological Survey Professional Paper 1240-C, 94 p.

Mowatt, T. C. and J. C. Mowatt, 1990, Diagenetic relationships and reservoir quality implications, Brookian clastic sequences, National Petroleum Reserve in Alaska: (abs.) Fifth Circum-Pacific Energy and Mineral Resources Conference, Honolulu, Hawaii.

Schmidt, V. and D. A. McDonald, 1979a, The role of secondary porosity in the course of sandstone diagenesis: in SEPM Special Publication No. 26, p.175-207.

Schmidt, V. and D. A. McDonald, 1979b, Texture and recognition of secondary porosity in sandstones: in SEPM Special Publication No. 26, p. 209-225.

